HAER,
OH,
18-CLEV,
33-

The Pennsylvania Railway Ore Dock OH-18
On Lake Erie at Whiskey Island 1.5 mi. W of Public Square
Cuyahoga County
Cleveland
Ohio

Photographs and Written Data

Historic American Engineering Record
National Architectural and Engineering Record
National Park Service US Department of Interior
Washington, DC 20243

Addendum to

The Pennsylvania Railway Ore Dock
(Cleveland & Pittsburgh Ore Dock)
Cleveland
Cuyahoga County
Ohio

HAER No. OH-18

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PHOTOGRAPHS

HISTORICAL AND DESCRIPTIVE DATA

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HISTORIC AMERICAN ENGINEERING RECORD

OH-18

THE PENNSYLVANIA RAILWAY ORE DOCK

(CLEVELAND & PITTSBURGH ORE DOCK)

LOCATION:	On Lake Erie at Whiskey Island, approximately 1.5. miles west of the Public Square, Cleveland, Ohio U.T.M.: 17.43900.4593800 Quad: Cleveland South
DATE OF CONSTRUCTION:	1911-1912
PRESENT OWNER:	Conrail Six Penn Center Plaza Philadelphia, Pennsylvania 19104
PRESENT USE:	Ore-unloading dock
SIGNIFICANCE:	When built, the Pennsylvania Railway Ore Dock was the largest ore-unloading dock on the Great Lakes. The dock featured four Hulett unloaders with bucket capacities of 17 tons; a 15-ton capacity ore stocking and rehandling bridge; and a one-million-ton ore storage yard. The Wellman-Seaver-Morgan Company of Cleveland built the dock equipment. The Hulett unloader, invented and developed by Clevelander George H. Hulett during the 1890s, revolutionized the handling of iron ore by reducing labor costs and unloading times. By 1913, Hulett unloaders were in use at almost every port on Lake Erie. Their widespread adoption led to larger boats especially designed to accomodate the Huletts.
HISTORIAN:	Carol Poh Miller October 1979

ACKNOWLEDGEMENTS

The author wishes to thank Bob Badza, formerly with Conrail, who arranged access to the C & P Ore Dock, and Frank V. Castenir, dock superintendent. Mr. Castenir kindly permitted several early photographs displayed in his office to be removed for photocopying. These photographs illustrate, as no words can, Whiskey's Island's long history--more than 125 years--as an ore unloading port.

Mary Lindenstruth, of the McDowell-Wellman Company, allowed the author to borrow the company's file on the dock, as well as the original engineering drawings of the dock machinery and several photographs taken shortly after the facility's completion. In addition, Ms. Lindenstruth permitted a copy to be made of the only known photograph of Cleveland inventor George H. Hulett, designer of the Hulett ore unloader.

Finally, thanks are due to dock foreman Rich Ginn, who spent a long, hot summer day guiding both the author and the HAER staff photographer about the dock. Mr. Ginn answered numerous questions about the dock's daily operations and the physical changes that have occurred there during the past several decades.

"The machinery that has done as much as, if not more than, any other to bring steel down to its present low price, is the labor-saving machinery used for handling the raw materials. . . While this portion of the process does not guarantee cheap steel, the lack of such appliances would absolutely prohibit it."

--James N. Hatch, "Modern Handling of Iron Ore on the Great Lakes," Journal of the Western Society of Engineers (1902)

"If you can imagine riding on a dinosaur's head while he's feeding, you can imagine how it feels to operate a Hulett. In repose, this monster is the ugliest, ungainliest machine ever made. In action, it's sheer poetry."

--William Donohue Ellis, The Cuyahoga (1966)

Iron ore was discovered in the Lake Superior region in 1844, although not until 1852 was any shipped down to the lower Great Lakes. Then the going was slow: ore had to be unloaded at the Sault Ste. Marie rapids, hauled by teams, then reloaded. The first cargo to arrive in Cleveland (1852) consisted of about two tons of ore packed in a half dozen barrels.[1] The opening of the Sault Ste. Marie canal in 1855 thus marked the real beginning of ore shipments and the problem of ore unloading.

The essential movement of iron ore is the same today as it was in 1855. Ore mined for the Lake Superior region is carried by rail to the shipping ports, then by ship to the lower lake ports, where it is re-handled into railroad cars for the trip to the blast furnace.[2] Between 1855 (the year of the first shipment through the Soo locks) and 1880, the annual product of the Lake Superior mines rose from 1,449 tons to 1,908,745 tons.[3] Thus the efficient re-handling of iron ore at the receiving docks became increasingly important in order to meet the steady demands of blast furnaces, to keep the price of ore low, and permit lake vessels to make a maximum number of return trips during the seven-month shipping season.

Early Ore-Unloading Methods

J. H. Strattib, in an article in the Journal of the Cleveland Engineering Society, has identified three phases of ore unloading prior to the introduction of the Hulett unloader in 1899.[4] At first, iron ore arriving at the lower lakes was unloaded entirely by hand labor; the ore was shoveled onto a staging, or platform, in the hold of the vessel, reshoveled to the deck, and again reshoveled into wheelbarrows and wheeled on gang planks to the dock. As the quantity of ore to be handled increased, tubs were filled by hand, then hoisted to deck level by horses and block and tackle; the contents of the tub were dumped into wheelbarrows and wheeled to the dock as the tub returned for another load. An average cargo of ore during this period was about 300 tons and required about four days to unload. In the second phase, between 1867 and 1880, portable steam engines were used to hoist the tubs of ore out of the hold, but men and wheelbarrows still carried the ore to the dock. The output of the Superior mines rose to 1,908,745 gross tons of iron ore by 1880, demanding its more efficient handling at the receiving ports.

The third phase of ore-handling technology was ushered in 1880, by a young Cleveland engineer named Alexander E. Brown (1852-1911). Brown developed a mechanical hoist that solved in some measure, the inefficiencies of hand labor. The invention consisted of two towers supporting a cableway. One tower was placed at the edge of the dock and one at the rear of the ore stockpile yard. A steam-powered rope trolley suspended from the cableway travelled out over the ship's hold and carried hand-filled tubs of ore back to the dock. Several tubs were placed in the hold so that the shovelers could fill one tub while the Brown unloader delivered a full one directly to a red car or to the stockpile.[5] The first Brown unloader was installed on the New York, Pennsylvania & Ohio (NYPANO) dock at Cleveland during the season of 1880-1881.[6]

Brown had received his technical training at the Brooklyn Polytechnical Institute and as an employee of the U. S. Geological Survey at Yellowstone Park and the Massillon (Ohio) Bridge Company. According to Cleveland historian William Ganson Rose, "while watching long lines of laborers slowly moving bulk cargoes of iron ore by wheelbarrow from vessel holds to [Cleveland's] Whiskey Island docks, he conceived the idea of an automatic hoist that would give the workmen 'something better to do.'"[7] The company Brown founded to manufacture his invention, the Brown Hoisting Conveying Machinery Company (later called the Brown Hoisting Machinery Company), soon expanded the scope of its products to include machinery for handling coal, limestone, and other bulk materials. Brown's numerous patents for hoisting and conveying machinery led the Cleveland Plain Dealer to pronouce him "the most prolific producer of mechanical ideas in Cleveland."[8]

The direct handling of ore from vessel to rail car or stockpile reduced the cost of unloading a ton of iron ore from 30-50 cents to about 18 cents.[9] It has been estimated that, by 1893, 75% of the iron ore unloaded at Lake Erie ports was handled by Brown hoisting machines. "Unequipped docks were helpless against the competition of those that had Brown hoist advantages," a Brown Company catalog later claimed.[10] The Brown method of ore unloading subsequently improved and refined but still modeled on the orginal invention - was widely employed until 1900. Other companies, including the King Bridge

Company and the McMyler Manufacturing Company, built ore-unloading machinery but, like the Brown hoist, all depended on a large labor force to shovel the ore into tubs.[11]

The Hulett Ore Unloader

The most radical improvement in ore unloading machinery was made by George H. Hulett (1846-1923) while employed as an engineer with the Webster, Camp & Lane Machine Company of Akron. Hulett's invention, first patented in 1898, did away with the shovelful "as a unit of bulk" and substituted a 10-ton capacity grab bucket. The first Hulett ore unloader, built for the Pittsburgh & Conneaut Dock Company at Conneaut, Ohio, in 1898-1899, marked "a new era in ore handling."[12]

George Hulett was born at Conneaut, Ohio, the son of pioneer settlers who had emigrated from Vermont in 1831. The family moved to Cleveland in 1860. Hulett attended the local schools and was graduated from the Humiston Institute in 1864. He conducted a general store at Unionville, Ohio, until 1881, when he returned to Cleveland and entered the produce and commission business.[13]

Hulett's technological leap from the general store to the design and manufacture of materials-handling equipment unfortunately cannot be documented. Patent records show that, between 1887 and 1906, Hulett secured over two dozen patents for a variety of hoisting and conveying machinery.[14] An obituary in the Iron Trade Review noted that, for thirty years, Hulett was "actively engaged" as a construction engineeer for a number of manufacturers of heavy machinery, including the Variety Iron Works and the McMyler-Interstate Company, both of Cleveland, and the Webster, Camp & Lane Company of Akron. When Webster, Camp & Lane later merged with the Wellman-Seaver-Morgan Company of Cleveland, Hulett served as vice-president and director of the combined companies until 1918.[15]

On 5 April 1898, Hulett, along with John McMyler, secured a patent for an improved "loading and unloading apparatus."

Hulett and McMyler's invention provided "means for reaching under the decks of vessels and unloading (cargo) rapidly and cheaply." According to tbe patent:

> ...it consists of a suitable framework for the support of the mechanism, a leg supported thereby and depending therefrom, and a scoop or bucket connected with the lower end of the leg and capable of being turned completely around relative to its support.

The new machine was designed to operate hydraulically, although "other means, such as steam or electricity, could be employed as well as water."[16] Hulett soon perfected the new machine and secured subsequent patents in his name alone.[17]

The Hulett ore unloader practically defies description, so unusual is it in appearance and motion. The machine consists of a main framework mounted on trucks which travel on tracks laid parallel to the dock. The main framework, perpendicular to the dock, is cantilevered at the rear so that it overhangs an ore storage trough. A trolley travels on rails mounted on the main framework. The trolley carries a walking beam from which a stiff vertical leg is suspended. There is a grab bucket at the low end of the leg, directly above which is an operator's cab.

The motions of the walking beam and bucket are controlled by cables attached to drums at the rear of the trolley and operated by direct-current electric motors located in a small room, called "the dog house," at the rear end of the walking beam. The walking beam may move forward and backward on the main framework, up and down from the vessel's hold, and laterally along the dock (to permit the retrieval of ore from the various hatches of a ship). The bucket can be rotated in a complete circle, allowing it to turn in any direction to gather a load of ore. When the operator has grabbed a load, the leg is raised out of the hold and the trolley supporting the walking beam is run back until the bucket is in position to deposit the ore into a dual hopper mounted on the main framework of the machine. The ore passes from the hopper into a "scale larry" suspended from the underside of the main framework. The ore is weighed, then run back in the larry and deposited in to the ore storage trough or into railroad cars positioned on tracks beneath the machinery.

The Hulett ore unloader resulted in substantial cost savings for the iron and steel industry, reducing the cost of unloading iron ore from 18 cents to less than 5 cents per ton. Such economy was possible largely because of the reduced cost of labor: the Hulett ore unloader required one operator in the bucket leg, one in the scale larry, an oiler, and "about five men in the hold for one quarter of the working time, to clean up."[18] With the improved handling machinery, a cargo of iron could be unloaded in 5 to 10 hours, (depending on the size of the vessel) thereby enabling a ship to make many more round trips each season. Finally, the widespread adoption of Hulett unloaders affected both the size and design of lake vessels. <u>Engineering News</u> reported in 1904 that "boats are now being designed with special reference to the economical working of the (Hulett) unloaders. The hatches are made practically continuous, and they are made as wide as the space used for the storing of cargo."[19] A retrospective review of Hulett's invention in 1923 further elaborated on its impact on lake shipping:

> Soon after the sucess of the Conneaut installation was firmy established, a radical change in vessel construction became apparent. Main deck beams and stanchions were omitted, and the hold was designed on the lines of a continuous hopper so that the ore was brought within the sphere of the unloading machines. The increase in size of lake ore carriers from 300 to 625 feet in length and from 3,000 to 13,000 tons in capacity during the past 20 years, has been largely the result of improvements in unloading.[20]

The Pennsylvania Railway Ore Dock

While the original builders of the Cleveland & Pittsburgh Railroad were not aware of the possibilities of trade in iron ore, they estimated that the line would move a thousand tons of coal a day. The western terminus of the road was on Whiskey Island, a strip of land west of the Cuyahoga River sheared off from the mainland by the old river bed. The line was completed through to Willsville, Ohio, in 1852 and shortly thereafter connections were made with Pittsburgh and the East.[21]

The unloading of Lake Superior ore on Whiskey Island probably began about 1855, although the exact date has not been recorded. In 1867-68, the Cleveland & Pittsburgh Railroad erected "special unloading facilities" to replace the tedious "100-ton-a-day-method" of the hand shovel and wheelbarrow:

> . . . steel drums sawed into halves - and later, iron tubs made especially for the purpose - were lowered into the holds by means of ropes passed through 'snatch blocks' in the ships' rigging. After being filled by shovelers, the tubs were then pulled back up by horses on shore hitched to the ropes. The ore was dumped into wheelbarrows pushed along platforms above the railroad cars and was then spilled into the cars or into storage piles.[22]

Steam engines later replaced horses as a power for the block and tackle.

In 1889, the Pennsylvania Railroad (which had leased the Cleveland & Pittsburgh line beginning in 1871) erected four "cantilever type mechanical unloaders" on Dock No. 1 on the old river bed. Two more were added at Dock No. 2 the following year. In 1891, a Brown "Fast Plant" unloader was built on Dock 3, "marking a new advance by handling 6,000 tons of ore a day direct from vessels to railroad cars." Additional equipment added in 1901 gave the dock the capacity to handle 2,200,000 tons of ore each season. The later adoption of clam-shell buckets, whicb eliminated the need for a large force of shovelers, further increased capacity.[23]

Mitchell & Company's Marine Directory for 1914 reported that, in addition to the new Hulett machines, the C & P Ore Dock was equipped with six Hoover & Mason Electric unloaders with 5-ton clam-shell buckets; twelve Brown Electric Fast Plants with 1-ton clam-shell buckets; and thirty-one Brown Hoists with 1-1/2-ton clam-shells. The dock could accommodate boats up to 607 feet in length.[24]

In 1908, the Pennsylvania Company decided to scrap its Whiskey Island operation in favor of a new dock on the lakefront, on property it owned north of the tracks of the Lake Shore & Michigan Southern Railway and within the protective arm of the Cleveland Harbor west breakwater. The lakefront site would eliminate the tortuous trip of bulk freighters around the hairpin curves of the Cuyahoga, a journey that, for larger boats, required the assistance of two tugs. The company proposed to reclaim approximately forty areas of lakefront land by filling it with slag and other refuse; construct an extensive ore dock equipped with modern Hulett Machinery; lay out an extensive yard system for the railroad cars that would receive the ore; and build a double-track subway beneath the tracks of the L. S. & M. S. Railway to permit rail access to the dock.[25]Between 1910 and 1912, the Pennsylvania Railway Company built the "latest and most modern ore dock the lakes" at Cleveland.[26] The new dock was located on the lakefront at Whiskey Island, a strip of land sheared off from the mainland by the old channel of the Cuyahoga River. The dock consisted of four Hulett ore unloaders each with a bucket capacity of 17 tons, a stocking and rehandling bridge with a 15-ton-capacity bucket, a one-million-ton-capacity ore storage yard, machine shop, office, and electric power house. Upon completion, the Pennsylvania dock at Cleveland was the largest ore-handling plant on the Great Lakes.[27]

To protect the Cleveland Harbor during the progress of construction and to facilitate the work, the company built a temporary wooden trestle parallel to the shore line and along the north face of the proposed dock. Fill material was placed simultaneously from the shore line outward and from the wooden trestle shoreward. Cars of fill were unloaded by hand labor and distributed and leveled by a track spreader. (Experiments with handling the material with a locomotive crane and grab bucket proved less economical than hand labor.) About one million cubic yards of fill were deposited, forming an area 1850 x 850 feet in size.

The ore dock consisted of a dock wall 985 feet long and a rear wall 800 feet long located 75 feet back from the dock wall; transverse walls tied the two together. Where the dock wall extended beyond the rear wall, its tie walls ended in concrete anchor blocks. All of the walls were built of reinforced concrete supported on concrete piles. The tracks carrying the front and rear legs of the Hulett unloaders were laid upon the dock and rear walls, respectively, thereby permitting the horizontal movement of the unloaders along the face of the dock.

The dock wall, a continuous concrete superstructure heavily reinforced with 85-lb. steel rails, was supported on a double row of 40-foot reinforced concrete piles spaced 3 feet apart on centers. Concrete sheet piles, 10 x 12 inches in section, were laid horizontally between the two rows of piles, both to form the face wall of the dock and to retain the landfill. The rear wall was supported on three rows of 30-foot piles spaced 4 feet apart on centers. The tie, or transverse, walls were spaced 30 feet apart on centers and were supported on 30-foot concrete piles. The space between the dock front and the rear wall was filled with rip-rap stone "varying from shovel size to derrick size." The stone was placed by a locomotive crane operating from a temporary wooden trestle. When this tone filling had been brought up to the water level, the whole mass was filled with sand pumped in by a hydraulic dredge. The space behind the rear dock wall was also filled with stone made solid by pumping in sand, forming a foundation for the U-shaped concrete ore trough from which the ore would be retrieved by the stocking bridge. The face of the dock was protected by a row of timber piles, 40 feet long, tied together with oak whaling pieces 12 x 12 inches in size.Two unreinforced concrete walls, each 10 feet high above ground, carried the tracks for the ore storage bridge. The wall closest to the dock was located 168 feet back from the rear dock wall; the walls were spaced 266 feet apart and each was supported on two rows of concrete piles. The wall carrying the main tower of the bridge was set with cast-iron brackets, spaced 10 feet apart, to support the conductor rails delivering electric current to the machinery. Both walls had mortised expansion joints at intervals of 32 feet.

A "floating mixer plant" prepared the concrete used for the erection of the dock superstructure. The concrete was delivered to the forms by chutes. The ore trough and the walls supporting the ore storage bridge were built after the rip-rap stone filling had been deposited. The concrete for this work was prepared in a "traveling" concrete mixing plant mounted on a railway car and supplied with material from cars of the same track. Laborers with wheelbarrows delivered the materials--cement, sand, and gravel--from the supply cars to the mixer car. For work on the upper part of the walls, a frame tower mounted on the mixer car supported an elevator bucket, which received the concrete from the mixer then raised and dumped its contents into a hopper, from which it was delivered by gravity through sheet-iron tubes. The concrete for the footings was deposited by chutes directly from the mixer. The was a 1:3:6 mixture (1 part cement to 3 parts sand to 6 parts aggregate). The dock contained a total of 18,400 cubic yards of concrete.

The reinforced-concrete piles were designed especially for building the dock. These were octagonal in section, measuring 13 inches across the flats. Each pile was reinforced with eight 1-inch steel rods spaced longitudinally and bound by a steel spiral of 3/8-inch rods. The piles were cast vertically in steel forms; a cast-iron "shoe" placed inside the form became part of the finished pile. A 1:2:4 concrete mixture, made with both gravel and 3/4-inch screened limestone, was used. The material for the piles was delivered by rail cars and handled by a locomotive crane. After each form was filled, it was fitted with a steel cap, then laid horizontally on a curing bed and "cured" with live steam for 12 to 24 hours (depending upon the weather). The forms were removed and the piles placed in a storage bed where they were kept covered and heated and allowed to season for at least 30 days.

Nearly 5,000 piles were required for the construction of the dock: 3,612 octagonal piles and 1,142 sheet piles. The Great Lakes Dredge & Dock Company built an extensive plant for their manufacture, including a cement warehouse, mixer, an elevator tower for casting the piles vertically, electric light station, and stockpiles of sand and stone. Most of the piles were made between January and March, 1911, and the materials were kept heated. After the required seasoning, the piles were loaded onto scows and towed to the site, where floating pile drivers drove them into place.

All of the machinery at the dock was designed and built by the Wellman-Seaver-Morgan Company of Cleveland. Unfortunately, extensive accounts of the dock's construction do not include information on the fabrication and erection of the dock machinery. Initially, all of the dock machinery operated by electricity generated at a power house at the west end of the plant. The power house, 150 x 60 feet, was steel-framed building with reinforced-concrete columns and floors and brick walls. Coal to fire the boilers was received in hopper cars over a wooden trestle above the concrete coal bunkers, located outside the building. A grab bucket operating on an elevated track carried the coal from the bunkers to the crusher. The crushed coal then passed by steel hoppers to the stokers. Water for the boilers was taken from Lake Erie through a 30-inch pipe to an intake well beneath the building. Overflow water was discharged from a hotwell back into lake through another 30-inch pipe. The power house originally was equipped with three 600 h.p. Babcock & Wilcox Stirling boilers equipped with Roney stokers and individuals steel stacks 66 inches in diameter and 25 feet high; two Dravo & Doyle centrifugal boiler feed pumps; three Allis-Chalmers non-condensing turbine-driven jet condensers; one 2,500 h.p. Cochrane water heater; one 800 k.w. Westinghouse rotary converter; two 50-light General Electric arc lamp tubs; and two 500-gallon Watson-Stillman general service pumps.

Power was carried by underground cables to the forward bridge and trough walls. The current was distributed through 85-lb. steel rails supported on cast-iron brackets bolted to the walls. Sliding shoes transferred the current from the rails to the walking beams, facilitating a continuous power supply. The lateral movement of the unloaders across the face of the dock and the ore gates of the 70-ton hoppers were powered by a 150 h.p. motor operating a drum upon which were would haulage ropes. A separate 35 h.p. motor operated the larry gates through a worm reduction gear. On top of the framework, the trolley carrying the walking beam carrying the grab bucket operated by ropes attached to the rear end of the walking beam and wound upon drums driven by a 300 h.p. motor mounted on the beam. A 100 h.p. motor geared to a drum upon which operating ropes were wound regulated the opening and closing of the bucket; the ropes were carried over deflecting sheaves at the top of the bucket leg and attached to an operating mechanism located on the leg above the operator. A 35 h.p. motor geared to a drum upon which rotating ropes were wound operated the bucket leg. A round trip from the boat to the hopper could be made in 50 seconds.

The ore stocking and rehandling bridge consisted of a truss bridge supported by a shear leg (toward the rear of the dock) and a main tower (closest to the Hulett machines). The bridge had a main span of 266 feet, with 173-foot cantilevers at each end. The main tower and shear leg were mounted on trucks that travelled on rails atop concrete walls. A 15-ton grab bucket, suspended from a trolley mounted on trucks on the underside of the bridge, transferred ore from the ore trough to the storage yard and, later, loaded it into railroad cars for shipment. Two 75 h.p. motors feared to the trolley axles drove the trolley. Like the Huletts, the action of the grab bucket was regulated by opening and closing ropes wound on separate drums and operated by separate motors in the trolley. The lateral movement of the ore bridge across the face of the dock was controlled from a house mounted on the maintower. Separate 75 h.p. motors drove the tower and shear legs of the bridge. The bridge operator's house was located so that the trolley operator could position the trolley opposite the house and step into it whenever the bridge had to be moved to a new position along the dock. Under favorable conditions, the stocking bridge handled about 1,000 tons of ore each hour.
The track system at the dock was arranged as follows: Empty cars were stored in a yard at the east end of the plant, from which they could be switched to one of four tracks beneath the unloaders or to a single track that ran along the north wall of the storage bridge. Loaded cars were assembled into trains in a large yard south of the storage yard. Thus the movement of cars at the dock was continuous.

Electric locomotives, called "shunt cars," moved the rail cars about the dock. These locomotives, made by Baldwin-Westinghouse, ran on narrow-gauge (42-inch) tracks and were equipped with "side pusher arms" designed to push, or "shunt" the cars along adjacent standard-gauge tracks. Conductor rails between the narrow-gauge tracks supplied power to the locomotives. The shunt cars handled both single cars and trains.

A machine shop at the west end of the dock, 60 x 70 feet in size, handled all necessary repair work on the dock machinery. A 25-ton Shaw crane extended across the tracks at the front of the building to handle parts directly from rail cars into the shop. A two-story office building, 25 x 40 feet, next to the machine shop was fitted with offices for the dock superintendent and his staff and a locker room for the dock crew.

In order for the Pennsylvania rail lines to reach the ore dock, the company had to construct a double-track subway beneath the seven lines of the Lake Shore & Michigan Southern Railway. The L. S. & M. S. tracks were raised 4 feet and a reinforced-concrete subway, supported on concrete piles, was built beneath them. The subway was built in sections, since only two of the L. S. & M. S. tracks could be abandoned at any one time. A wood pile trestle carried the L. S. & M. S. tracks during the course of construction.

The ore dock was designed and built under the direction of R. Trimble, chief engineer, maintenance of way, for the Pennsylvania Company's Northwest System. The Great Lakes Dredge & Dock Company constructed and drove all of the concrete piles and built the foundations for the power house and the substructure of the subway. The Dravo Contracting Company built the concrete ore trough.

The development of the Hulett ore unloader in the first decade of this century wrought no small revolution in the transportation end of the iron and steel industry. One contemporary writer, noting the immense constrast between the new Hulett machine and the old-style dump bucket, observed:

> The little mouthful of ore which the dump bucket brings up from the hold seems scarcely worth while when compared with the ten-ton grab made by Hulett. . . One cannot watch these huge steel birds, dipping their bills down into the hold of a boat without marveling at the genius and daring of the inventor. . . To be sure, it is not a very graceful looking bird, but, as the steel man says, "it delivers the goods," and that is his first and last demand.[29]

The Marine Review and Marine Record reporting on the success of the first Hulett installation at Conneaut, declared that the new equipment left "no doubt as to the complete development of . . . machines that will soon do away almost entirely with the old method of shoveling the ore into buckets in the holds of vessels."[30] Another writer commented that "it would be no surprise if their introduction marked the era of a complete change in unloading machinery."[31]

By 1913, forty-five Hulett unloaders were in operation on the Great Lakes. Except for two on Lake Superior and five at Gary, Indiana, all were located at ports on Lake Erie.[32] While no exact statistical measurement is readily available to show the Hulett's economic impact, the machine no doubt played a central role in handling the output of the Superior mines, which rose from 19 million gross tons in 1900 to more than 48 million tons by 1912.[33] At the

Pennsylvania dock in Cleveland, on 2 July 1915, 11,083 tons of ore were unloaded from the steamer "James A. Farrell" in 3 hours, 35 minutes. This record was broken again and again by the efficient Huletts, which still enjoy supremacy on the docks of Lake Erie. The machinery at the Pennsylvania dock long remained a subject of interest to metal trades conventioneers visiting Cleveland, whose meetings often featured a visit to the dock on Whiskey Island.[34]

The Operation of the Dock Today[35]

With a few exceptions, the Cleveland & Pittsburgh Ore Dock (or the "C & P Dock" as it is more commonly known) operates the same way today as it did in 1912. Lake Superior iron ore, screened and sorted according to its chemical properties, is loaded by chutes into a vessel at the upper lake port. When the ship has been loaded, an upper lake dispatcher informs the lower lake dispatcher of the ship's departure time, tonnage, and destination. The lower lake dock dispatcher passes this information to the unloading dock and to the railroad. Trains of empty cars are readied in a classification yard according to the consignee's requirements (since railroad car unloading facilities at the various mills may differ). Small yard engines move the cars to the empty receiving yard at the west end of the dock.

When the boat arrives, electric "shunts" shuttle the empty rail cars into place beneath the Hulett unloaders. There are four unloading tracks, one for each Hulett machine. The shunts run on narrow-gauge tracks between each two unloading tracks. The shunt's "side pusher arms," powered by compressed air, may drop on either side to engage the end sills of the rail cars, thus enabling them to move cars on two tracks at the same time. During unloading, the shunts keep the cars in proper position under the Huletts for even loading. There are six shunts at the C & P Dock, including two formerly employed at Cleveland's Erie Dock, now abandoned. Each shunt is able to handle from 10 to 12 empty cars or 6 loaded cars at a time.

With the empty cars in place below, the Huletts begin the work of unloading the ore. Each machine requires three persons to operate: the Hulett operator, the "larryman," and an oiler. The Hulett operator sits in a cab in the leg above the bucket. He controls the movements of the walking beam and bucket, as well as the lateral movement of the entire machine along the face of the dock. When the bucket has taken its 17-ton bite of ore, it is raised out of the hatch and run back until it is in position to empty its load into dual receiving hoppers supported on the main framework of the Hulett. The larryman discharges the ore in the receiving hopper through dis-type gates into a "scale larry." The larryman, seated in a cab inside the scale larry, records the weight and then moves the larry horizontally until it is in position above an empty rail car. He discharges the ore through a hopper into the car, then returns to the receiving hopper for another load. The process is repeated until the rail car is full. The shunt shuttle empties cars beneath the hopper as they are needed, and meantime pushes loaded cars to the east end of the yard, where they are made up into trains. Trains dispatched from the C & P Dock usually consist of 80 to 85 loaded cars plus caboose.

The operation of the Huletts is coordinated by a foreman stationed on the deck of the vessel. It is his job to see that the ship is unloaded efficiently and that is is kept at an even keel to avoid undue stress to the hull. To accomplish this, the Huletts are frequently shifted laterally along the dock during unloading. Another foreman keeps watch over the operation on the dock.

When the majority of the cargo has been unloaded, tractor scrapers assisted by gangs of shovelers "clean up" in the hold. The Hulett machines act as cranes, lowering the tractors into the hold. The ore that has scattered to the corners of the vessel or otherwise out of reach is gathered together in piles for the final few grabs by the Huletts. The tractor scrapers were first introduced for "clean-up" about 1952; previously only shovelers did the job.

If the ore is not to be shipped immediately, the larryman moves his car along the cantilever at the rear of the Hulett and deposits the ore into the storage yard. About 90% of the ore arriving at the C & P Dock is shipped immediately, however, and the storage yard at the dock does not grow appreciably large until fall, when many mills store surplus ore at the dock for shipment durng the winter months, after dock operations have ceased. The ore bridge that formerly transferred ore within the storage yard was destroyed by a blizzard in January 1978, and the work of the bridge has since been taken over by front end loaders equipped with scales. The concrete walls of the ore storage through have been removed. Since the 1930s, power has been purchased commercially rather than manufactured at the dock's power house. Some original equipment remains, including three 500 k.w. Westinghouse rotary converters, which convert electricity to the direct current required by the Hulett machinery. The dock's original office and machine shop are still in use.

The C & P Ore Dock, owned by Conrail since 1976, is leased and operated by the Ohio & Western Pennsylvania Dock Company, a wholly-owned subsidiary of the Hanna Mining Company. Boats tying up at the C & P Dock generally are in the 6,000 - to 8,000-ton class, although some carry as much as 32,000 tons. With all four Hulett machines working, an average of 3,000 long tons can be handled each hour. Approximately 80 men working two 8- to 12-hour shifts, six days a week, are required during the shipping season. Today the shipping season runs eight or nine months, usually beginning in April and ending in late December or early January. The majority of ore unloaded at the C & P Dock is shipped inland to furnaces in Ohio, Pennsylvania, and West Virginia. Ore unloaded during the week of this writer's visit to the dock was bound for Weirton, West Virginia, East Steubenville, Ohio, and Midland and Aliquippa, Pennsylvania.

Frank Castenir, superintendent of the C & P Ore Dock, predicts that the Hulett unloaders will remain in active service for at least the next twenty years.[36] The ore vessels now working the lakes still have many years of productive service before they are replaced by a technology even more revolutionary than the Huletts. One observer's musings in 1913 were prophetic:

> . . . whatever improvements are made in ore handling in the future, if we are to make any great increase in capacity, must come through some such radical change as was made in the methods when the excavating bucket and the Hulett machine superseded the hand shovel.[37]

One-thousand-foot self-unloader boats, which carry their own conveyor systems, eventually will lead to the replacement of the Huletts. The first such boat to tie up in Cleveland arrived at the C & P Dock this summer, on the evening of 12 August 1979. The "George A. Stinson," carrying 57,000 tons of iron ore pellets, was part of Conrail's experiment to see what changes will be needed at the dock to accommodate the huge vessels for regular commercial service.[38]

Should the Hulett, as expected, operate for another twenty years, the lanky machines - which, on a clear night, look not unlike constellations dancing on the horizon - will have given just short of a century's service. The Hulett machines will have transformed, not only ore-unloading technology, but the industrial landscape of port cities on the lower lakes.

Footnotes:

1 James F. Rhodes, "The Coal and Iron Industry of Cleveland," Magazine of Western History 2 (May-October 1885): 341.

2 Since the late nineteenth century, the bulk of the lake shipments of iron ore has been taken to the lower lake ports--Cleveland, Fairport, Astabula, Toledo, Sandusky, Huron, Conneaut, and Lorain Ohio; Erie, Pennsylvania, Ohio, West Virginia, and New York. The remaining portion goes direct to furnaces situated near or on the Great Lakes, Milwaukee, Chicago, and Detroit, for example. See John Birkinbine, "From Mine to Furnace," Cassier's Magazine 4 (September 1893): 354.

3 "Iron Ore Statistics" in Annual Report of the Lake Carriers' Association, 1913 (Detroit: P. N. Bland Printing Co., n.d.), p. 183.

4 "The Development of Ore Unloading on the Great Lakes," Journal of the Cleveland Engineering Society 6 (July 1913): 3-4.

5 See Patent No. 232.236. "Hoisting and Conveying Machine," A. E. Brown, Cleveland, Ohio, filed 24 June 1880, Specifications and Drawings of Patents Issued from the United States Patent Office for September, 1880 (Washington: Government Printing Office, 1880), pp. 428-435.

6 Stratton, "Development of Ore Unloading," p. 7.

7 Cleveland: The Making of a City (Cleveland and New York: The World Publishing Company, 1950) p. 437.

8 Industrial Supplement, 7 June 1909, p. 6A. The Brown Company, with its main office and works at Cleveland, merged with the Industrial Works of Bay City (Michigan) in 1923 and changed its name to Industrial Brownhoist Corporation. Industrial Brownhoist abandoned its Cleveland works in 1934. The former Brown Hoisting Machinery Company plant, designed by Cleveland architect Milton J. Dyer and built by the King Bridge Company in 1901-1902, still stands at the corner of Hamilton Avenue and East 45th Street.

9 Walter G. Stephan, "Modern Ore Handling Machinery-I.," Iron Trade Review 42 (14 May 1908): 891.

10 The Brown Hoisting Machinery Company, Brownhoist General Catalogue, 1919 (Cleveland: n.p., 1919), pp. 8-9. Subsequent improvements in Brown ore hoisting machinery--including the development of a clam-shell bucket and, later, a "manriding" trolley--eliminated the need for hand-filled tubs entirely. Unfortunately, the Brown Company catalog does not date the introduction of these improvements. See pp. 8-11.

11 Stratton, "Development of Ore Unloading," pp. 7-11.

12 Ibid., p. 12.

13 Elroy McKendree Avery, A History of Cleveland and Its Environs, 3 vols. (Chicago and New York: The Lewis Publishing Company, 1918), 3: 130.

14 Annual Report of the Commissioner of Patents, 1887-1888, 1890-1896, 1898-1906 (Washington: Government Printing Office, 1887-1906).

15 R. C. Allen, "The Significance of G. H. Hulett's Work," Iron Trade Review 72 (25 January 1923): 316. Also see Hulett's obituary, Cleveland Plain Dealer, 18 January 1923, p. 2. The exact dates of Hulett's tenture with these firms unfortunately are not indicated.

16 Specifications and Drawings of Patents Issued from the United States Patent Office for April, 1898, Part 1, Vol. 311 (Washington: Government Printing Office, 1898), pp. 81-83.

17 Hulett's patents for the new ore unloader were issued on 5 July 1898, 26 June 1900, and 18 November 1902.

18 Stephan, "Modern Ore Handling Machinery," pp. 891, 893. Stratton ("Development of Ore Unloading," p. 15) reports that at the time the first Hulett unloaders were put in service at Conneaut, "it was costing about nineteen cents a ton to unload ore, while with this machine it was possible to handle it for less that six cents a ton."

19 Charles H. Wright, "Modern Methods of Handling Iron Ore From Minnesota Mines to Pittsburg Furnaces," Engineering News 51 (5 May 1904): 434. Scientific American (Frank McClure, "Gigantic Ore-Handling Machinery," 20 June 1903, p. 469) reported the construction of new Lake ore carriers "with special reference to the proper accommodation of the Hulett automatic unloaders."

Stratton (Development of Ore Unloading," p. 5) shows that the average cargo of iron ore rose from 1,8000 tons in 1895 to more than 7,000 tons by 1907.

20 Allen, "Significance of G. H. Hulett's Work," pp. 316-317.

21 Rose, Cleveland, pp. 223, 240.

22 The Ohio and Western Pennsylvania Dock Company, (The Pennsylvania Railroad's Cleveland Docks (Cleveland: n.p., 1946), pp. 14, 19. This volume, published to clebrate the Pennsylvania Railroad Centennial and City of Cleveland Sesquicentennial, contains the only known accout of the early operation of the Cleveland and Pittsburgh Dock.

23 Ibid., pp. 20-21.

24 Fred W. Green, comp., Mitchell & Company's Marine Directory of the Great Lakes (Cleveland: n.p., 1914), p. 274.

25 Unless otherwise noted, the account of the construction of the Pennsylvania ore dock which follows is taken largely from these sources: "Ore Dock at Cleveland O.," Engineering News 67 (22 February 1912): 320-324 and "Pennsylvania Ore Unloading Dock at Cleveland," Railway Age Gazette 52 (23 February 1912): 335-340.

26 Stratton, "Development of Ore Unloading," p. 21.

27 George E. Edwards, "Unloading Iron Ores on the Lower Lakes," Mining and Engineering World 40 (20 June 1914): 1156.

28 Details of the electrial system is taken largely from Edwards, "Unloading Iron Ores," pp. 1157-1159.

29 Walter G. Stephan, "A 1908 Iron Ore Handling Plant," Iron Age 82 (8 October 1908): 985.

30 "Radical Change in Lake Ore Business," Marine Review and Marine Record 26 (21 August 1902): 17.

31 James N. Hatch, "Modern Handling of Iron Ore on the Great Lakes," Journal of the Western Society of Engineers 7 (December 1902): 547.

32 Stratton, "Development of Ore Unloading," pp. 4, 25 A list of ore unloading docks at the lower lake ports, issued in 1952, shows that Hulett-type unloaders were operating at Toledo, Huron,

Lorain, Astebula, and Conneaut, Ohio, (in addition to Cleveland, which had five docks equipped with Hulett). Erie, Pennsylvania, and Lackawanna, New York. See the Lake Superior Iron Ore Association, Lake Superior Iron Ores: Mining Directory and Statistical Record of the Lake Superior Iron Ore District of the United States and Canada, 2nd ed. (Cleveland: The William Feather Company, 1952), pp. 286-287.

33 Annual Report of the Lake Carriers' Association, 1913, p. 183.

34 For example, members attending the 1915 annual meeting of the American Iron and Steel Institute paid a visit to the dock, as did delegates to the National Metal Congress, held in Cleveland in 1929. See Iron Trade Review 57 (28 October 1915): 848 and 85 (29 August 1929): 517.

35 The following description of the dock's operation is based on a tour of the dock with foreman Rich Ginn, 27 September 1979, and Raymond C. Dryer, "Iron Ore--From Mine to Ship" and "Ore Movement from Lower Lake Docks to the Mill," unpublished papers prepared by an employee of Pittsburgh Steamship Division, United States Steel Corporation, undated.

36 Interview with Frank V. Castenir, Ohio & Western Pennsylvania Dock Company, Cleveland, Ohio, 12 July 1979.

37 Stratton, "Development of Ore Unloading," p. 23.

38 Cleveland Plain Dealer, 13 August 1979.

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